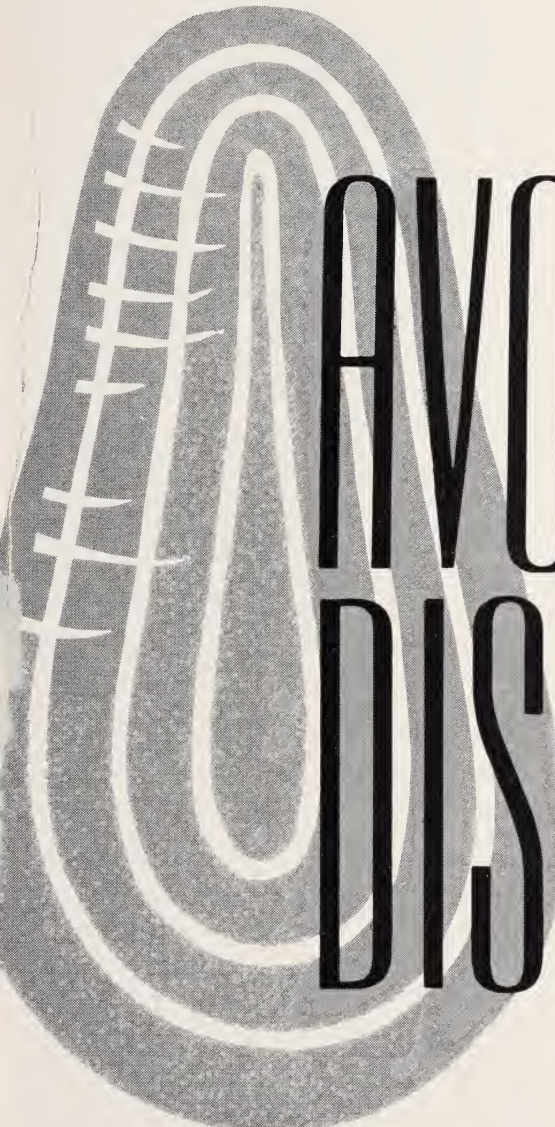




Division of Agricultural Sciences

UNIVERSITY OF CALIFORNIA

A large, stylized illustration of an avocado, rendered in shades of gray and white, positioned behind the title text.

AVOCADO DISEASES

George A. Zentmyer

Albert O. Paulus

C. D. Gustafson

J. M. Wallace

R. M. Burns



Healthy avocado tree.

AVOCADO DISEASES

This circular discusses symptoms, prevention, and control of the principal avocado diseases in California. In contrast to the tropical areas, where fruit rots and leaf spots are common, avocado in California suffers mostly from root rot and canker type diseases.

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THE AUTHORS:

G. A. Zentmyer is Professor, Department of Plant Pathology, Riverside; A. O. Paulus is Extension Plant Pathologist, Riverside; C. D. Gustafson is Farm Advisor, San Diego County; J. M. Wallace is Professor, Department of Plant Pathology, Riverside; and R. M. Burns is Extension Horticulture Technologist, Riverside.



Avocado tree affected by *Phytophthora* root rot.

Phytophthora Root Rot

AVOCADO root rot, or *Phytophthora* root rot, is the most serious avocado disease in California as well as in most of the other avocado-producing areas of the world. It is caused by the soil fungus, *Phytophthora cinnamomi*, and thrives under conditions of excess soil moisture, usually found in soils with poor internal drainage. Trees of any size, from nursery stock to large, old trees may be affected.

Symptoms

The leaves of infected trees are smaller than normal, usually pale or yellow green instead of dark green, and often are wilted. Leaves tend to drop, giving the tree an unthrifty appearance. New growth is usually absent; if new leaves are formed, they are small and of poor color.

Branches die back in advanced stages of the disease, and usually become sunburned because of the lack of foliage. Dis-

eased trees frequently set an abnormally heavy crop of small fruit.

Many of the small feeder roots on diseased trees are blackened, brittle, and dead. In advanced stages of the disease it is difficult to find feeder roots. Roots of pencil size or larger are seldom attacked by the fungus. The absence of feeder rootlets prevents the uptake of moisture, hence soil under diseased trees often stays wet.

Spread of the Fungus

Phytophthora cinnamomi is a soil fungus which can be spread by moving contaminated nursery stock of avocado and other plants, in water moving over or through soil containing the fungus, on cultivation equipment, or by other types of activity by man or animals in which moist soil is moved from one place to another.

Prevention

Plant on well-drained soil.—Root rot develops primarily in soils that have poor internal drainage because accumulated moisture permits the fungus to form its spore stages and to infect the roots. Extensive soil surveys in California have shown that avocado root rot damage is closely correlated with soil series. In new plantings, avoid soils favorable to root rot development; in established plantings manage soils carefully so that moisture does not accumulate in the soil. Contact your University of California Farm Advisor for information on the best soils for avocados.

Use disease-free nursery stock.—In past years diseased nursery stock has been one of the major reasons why the fungus spread throughout the avocado-producing areas of southern California. Methods are now available by which nurserymen can grow stock that will be free of the fungus. These methods involve heat-treatment of seed, fumigation or steam treatment of soil, and sanitation to prevent infestation of container-grown stock.

Prevent soil or water movement from infested areas.—The fungus can be moved by any means by which moist soil is moved, and also can be spread downhill from an infested area by surface or sub-surface drainage water. Install watertight drains to take care of surface runoff if a diseased area lies above your healthy grove. Control gophers, as their runs can provide means of moving the fungus in water.

Control

Irrigate diseased trees and margins of diseased areas carefully.—Since high soil moisture favors root rot development, careful irrigation can retard the spread of the disease and often prolong the life of affected trees. Do not water soil that is already wet, as this increases the disease problem. Remember that diseased trees use very little water because they have fewer feeder roots.

Fumigate small spots of disease.—If only a few trees are affected, and the disease is detected early, cut off the trees at ground level and fumigate the soil with

heavy dosages of one of the following soil fumigants: Vapam, Mylone, D-D, Telone. See University of California Circular 511 for concentration and methods.

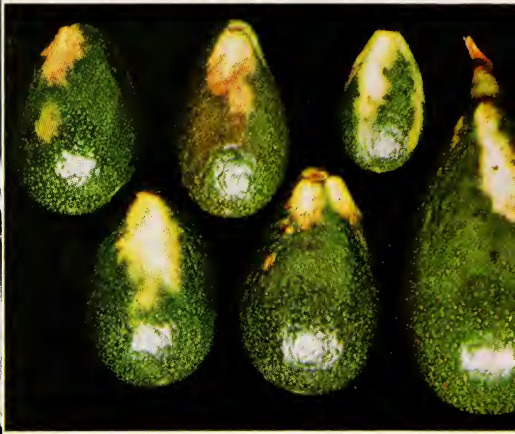
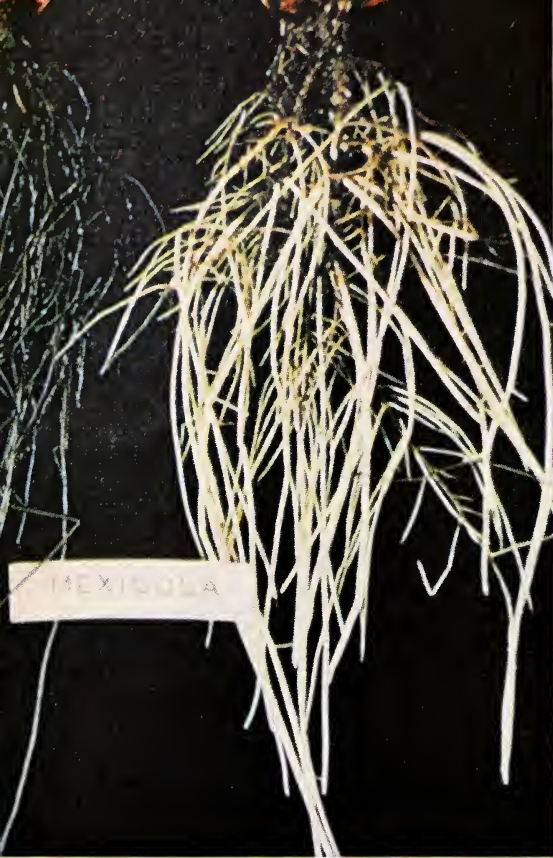
Establish a barrier.—If the disease situation is such that the fungus occurs in only one area and cannot spread downhill in surface runoff or drainage water into the part of the grove to be protected, a chemical barrier should retard spread. Establish the barrier at least two tree rows beyond where tests indicate the fungus to be present. Treat a five-foot wide strip with Vapam, Mylone, D-D, or Telone every six months.

Resistant rootstocks.—Some resistance to root rot has been found in the Duke variety, but this resistance does not approach the high level found in small-fruited non-graft-compatible species from Latin America. Cuttings of the Duke variety and of selected seedlings are more resistant than seedlings. Until selections from Duke types can be made available commercially, or until cuttings can be propagated more readily on a commercial scale, you may try Duke seed as a root-stock source. However, Duke seed germination is usually less rapid and uniform than other common Mexican types such as Topa-Topa and Mexicola.

Soil fungicides.—Dexon, a new soil fungicide with low toxicity to the avocado, shows promise in retarding root rot development when applied to established trees through the irrigation system; however, this is not a University of California recommendation at this time.

Crop rotation.—Replanting the infested soil to resistant crops is one of the best ways to control avocado root rot. The fungus has a wide host range but there are many plants that are not susceptible, including all varieties of citrus, cherimoya, persimmon, all types of vegetables, most annual flower crops, and many deciduous fruit trees and berries. Macadamia is highly resistant to *Phytophthora* root rot; a few cases of *Phytophthora* trunk canker have been found on macadamia trees in California.

See University of California Circular 511 for additional information on this disease.



Left, phytophthora root rot on avocado roots, Mexicola variety. The diseased root is darkened, the healthy root retained its color. Above, sun blotch virus symptoms on avocado fruits.

Armillaria root rot. Left, fungus mushroom stage; right, root showing white fungus mycelium under the bark.





Dothiorella canker on avocado trunk.
Note white exudate on bark.



Dothiorella fruit rot appears as small,
purplish-brown spots on the fruit.



Verticillium wilt. Left, symptoms on branches
consist of brown streaks. The branch on the far
left is healthy. Above, wilting and collapse of
entire branch in an avocado tree.

Armillaria Root Rot

Armillaria root rot may cause occasional damage, sometimes severe, to avocado trees in California. This disease is caused by the fungus *Armillaria mellea*. The fungus has also been popularly called the oak-root fungus because many infestations can be traced back to old oak trees. It attacks a wide range of plants, including citrus, stone fruits, and many ornamental trees and shrubs.

Symptoms

The fungus, *Armillaria*, becomes well established in the roots before any visible effects appear in the top. There may be a gradual deterioration in vigor, with the foliage yellowing and dropping over part or all of the tree; or there may be a sudden wilting and collapse. Death of the tree usually follows.

The most reliable sign of *Armillaria* root rot is a white, fan-shaped growth of the fungus mycelium under the bark. Purplish-brown cord-like rhizomorphs appear on the surface of diseased roots. The rhizomorphs resemble small, dark roots, but are composed of fungus cells.

The *Armillaria* fungus may produce a mushroom stage around the base of the infected tree during the rainy fall and winter months. The top of the mushroom cap is honey-yellow to almost black, and may have a covering of brown scales. A great number of spores are produced, but it has not yet been established whether they are an important source of infection.

Spread of the Fungus

Armillaria root rot spreads from place to place on infected wood. This wood may be a root fragment, or part of an infected nursery tree. It may be carried by flood water, by cultivating equipment, by any of man's activities which might move infected wood and soil. Long after the aerial parts of the tree are gone, the fungus remains alive in the roots. When susceptible trees such as citrus, peach, or avocado are planted in such soil and the roots come in contact with the fungus, they are exposed to infection. Infection is accomplished by direct penetration of a rhizomorph into the bark. The fungus spreads from tree to tree in diseased areas in the orchard, mainly by growing along diseased roots and infecting the healthy roots.

Control

Armillaria fungus is very sensitive to drying, and a tree's life may be prolonged by exposing the base of the tree to the air. Soil fumigation with chemicals has successfully controlled *Armillaria* root rot under favorable soil conditions, by preventing spread of the fungus and permitting replanting of fumigated areas. See University of California Circular 525 entitled "*Armillaria* Root Rot" for additional information you may want to get on control measures.

Sun-Blotch—A Virus Disease of Avocado

The avocado is known to be infected with only one virus disease, called sun-blotch because the symptoms resemble sunburn. The name has been retained even though the disease was demonstrated to be caused by a virus.

Symptoms

The most consistent symptom of sun-blotch and the only one useful in diagnosis is the streaking and spotting of the bark

of twigs, limbs, and on fruit. The streaks are usually yellow but at times, especially on young trees, the streaks may be whitish or almost colorless, and fruit lesions reddish. On occasion the first symptoms, particularly those developing on young budded trees, are in the form of a few small yellow spots. The streaked areas, on both the stems and fruits, are often depressed.

Sun-blotch infected trees sometimes produce clusters of leaves showing marked

white or pink mottle or variegation. The fruits of some affected trees quite commonly have depressed streaks, usually extending onto the fruit from the stem end. In some instances the fruits are badly marked and are small and misshapen. The number of affected fruits on diseased trees may vary from none, or very few, on some trees to many on others. The absence of fruit and leaf symptoms is not proof that a tree is not infected. Some avocado trees are carriers of the sun-blotch virus without displaying any of the known symptoms of the disease.

Spread of the Virus

The use of diseased propagative material is responsible for most of the sun-blotch in avocado trees. The use of budwood from diseased trees results in diseased progeny trees. The virus may also be transmitted through the seed. Certain avocado trees are symptomless carriers of the virus, and nearly all of their seedling

progeny are also carriers of the virus. If grown as seedlings, these trees will never show symptoms of sun-blotch, but when used as rootstocks and top-worked to sun-blotch-free scion varieties, the resulting budlings will develop severe symptoms of the disease.

As far as is known, the sun-blotch virus is *not* transmitted by an insect.

Prevention

Control of sun-blotch is strictly a matter of prevention. The propagator of avocado trees must know that the scion variety parent source and the rootstock parent are free of the sun-blotch virus. Accurate diagnosis for the disease can be made only by indexing. After inoculation and infection with the virus, an avocado test seedling requires from three months to two years to express symptoms of sun-blotch.

Avocado trees already infected with the sun-blotch virus cannot be cured.

Verticillium Wilt

This disease is caused by the soil fungus *Verticillium albo-atrum*, quite a different type than the *Phytophthora* root rot fungus. The fungus enters the roots and invades the water-conducting system, retarding or preventing water movement to the foliage from the roots. Verticillium wilt is not as serious or as common a disease in California as is *Phytophthora* root rot.

Symptoms

The leaves suddenly wilt on one part of the tree, or on the entire tree, then turn brown, die, and remain attached to the branches for several months. Brown to grey-brown streaks are seen in the wood of the branches or roots when the bark is peeled. Often trees affected with Verticillium wilt send out new, vigorous shoots within a few months after the initial collapse of the tree and the tree may recover completely.

Prevention

Use Mexican rather than Guatemalan rootstocks; the former are more resistant to this disease.

Do not plant avocados on land that has been used for other crops susceptible to Verticillium wilt, such as tomato, eggplant, pepper, many berries, apricot, potato, and a number of flower crops.

Do not interplant susceptible crops in an established avocado grove.

Do not use trees that are or have been affected with Verticillium wilt as sources of budwood or seeds.

Control

Often, no treatment is necessary as trees recover completely. Dead branches should be removed after dieback has ceased and new growth has begun. In case of severe and recurring disease, fumigate the area with chloropicrin (4 to 5 cc per square foot of soil surface) at least four weeks before planting another avocado tree.

Phytophthora Canker

The avocado root rot fungus (*Phytophthora cinnamomi*) and another closely related fungus (*P. cactorum*) can cause lesions or cankers on the lower trunks of avocado trees. This type of disease is not common on avocado in California but is occasionally a problem.

Symptoms

The bark shows discoloration, and usually a powdery white material (avocado sugar) exudes from the affected bark. When the bark of the canker area is cut into, it is found to be brown instead of whitish or cream-colored. This brown discoloration with *Phytophthora* cankers usually extends into the wood, in contrast to *Dothiorella* canker where the discoloration is limited to the bark.

Phytophthora cankers usually have a fermented odor. They are further distinguished from *Dothiorella* cankers by the fact that they originate at or below ground level.

Affected trees show a gradual loss of vigor and decline of the top, similar to symptoms exhibited by trees affected with *Phytophthora* root rot. Occasionally, in advanced stages, trees will die suddenly, with leaves turning brown within a short space of time.

Prevention and Control

Do not keep the lower trunks wet for long periods, as in basin irrigation, as this increases the chances of infection. Avoid wounding the trunks.

There is some indication that Guatemalan varieties are more susceptible than Mexican, but the difference is not as striking as with *Dothiorella* canker.

If cankers are detected in an early stage, before much of the trunk is invaded, they can be controlled by cutting out the infected tissue and painting the treated area with a fungicidal paint such as bordeaux paste.

Dothiorella Canker

Another, less serious type of canker, is caused by the fungus *Dothiorella gregaria*, the same fungus that causes fruit rot in California. This type of canker may appear on branches on various parts of the avocado tree and also may be found on the trunk.

Symptoms

The principal evidence is a white powder that exudes from the bark and a cracking and shedding of the outer bark. Affected trees sometimes gradually die back and look unthrifty; in unusually severe cases the tree may be killed. Examination of the affected trunk or branches will show brownish discoloration of the bark which is quite shallow; the bark flakes off easily.

Prevention and Control

Mexican varieties are much more resistant to this disease than are Guatemalan, and should be used as rootstocks.

The disease is favored by moist conditions. Do not let dead leaves and debris accumulate around the trunks or lower branches, particularly if the tree is on Guatemalan rootstock or if the scion is Guatemalan and the tree is budded low.

Control measures are usually not needed, but in the case of severe and recurring infection spray the lower trunks with bordeaux mixture or a similar fungicide several times during the rainy season. If lesions are abundant on the trunk, scraping the outer bark will remove some of the infection and encourage regeneration of vigorous bark.

Dothiorella Fruit Rot

The only fruit disease that occasionally causes damage in California is known as Dothiorella rot and is caused by the canker-inducing fungus *Dothiorella gre-garia*. This has sometimes been a problem on the coast, but is not important in the principal avocado-producing areas.

Symptoms

This disease does not appear when the fruit is still on the tree but develops after the fruit is picked and starts to soften. Small, purplish-brown spots may then appear on any part of the fruit. These spots gradually enlarge and may involve the entire fruit surface. The flesh is invaded by the fungus, becomes discolored, and develops an offensive odor.

Disease Prevention

The fungus commonly grows on dead leaves, dead margins of leaves, and on

dead branches. Do not let dead material accumulate in the groves. Also, avoid saline conditions which induce leaf-burn-ing of leaves because the fungus will live on the dead portions of the leaves. Use of low sprinklers instead of overhead sprinklers also will reduce disease inci-dence. The disease can be avoided by early picking of fruit, for example, har-vesting Fuertes in San Diego County coastal areas in December.

Control

If Dothiorella rot is a continuing and severe problem in your area, it can be controlled by spraying the trees with fungicides. Bordeaux mixture and some of the organic fungicides such as zineb have proven effective. Apply two or three times during the rainy season. Under some grove situations the expense and difficulty of applying a fungicide make this control measure impractical.

NOTE: Under California orchard conditions, nutritional deficiencies are known to exist in avocado for nitrogen, iron, and zinc. Excesses exist for nitrogen, chlorides, sulfates, and sodium. Visual symptoms, soil and leaf analysis, and control by fertilization are discussed in leaflet 24 revised, "Avocado Fertilization." Readers interested in leaf analysis will find additional details in the article "Leaf analysis as a guide to nitro-gen fertilization of avocados" by T. W. Embleton, W. W. Jones, and M. J. Garber in the California Avocado Society Yearbook 1959, pages 94-95.

To simplify this information, it is sometimes necessary to use trade names of products or equipment. No endorsement of named products is intended nor is criticism implied of similar products not mentioned.



THE GOOD EARTH

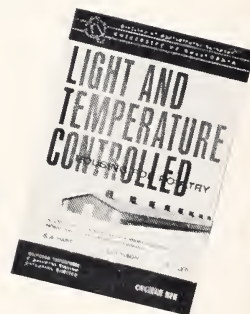
... is the abundant earth. To achieve it, vast knowledge is needed now—and more will be required as expanding populations continue to make even greater demands upon the earth's resources.

How are scientists, researchers, and agriculturists developing and implementing knowledge which will make the good earth flourish for future generations? In part, the answer will be found in the many publications put out by the University of California's Division of Agricultural Sciences. Among these publications are:

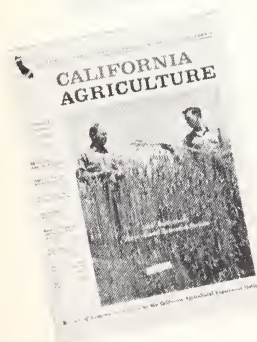


the BULLETIN series . . . designed for an audience of scientists, and for informed laymen interested in new research.

the CIRCULAR series . . . intended for a popular audience, and offering extensive discussions of some phase of an agricultural operation



CALIFORNIA AGRICULTURE . . . a monthly magazine describing latest research in the Division of Agricultural Science, and designed for researchers, informed farmers, and agri-businessmen



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